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(54) Title: SYSTEMS USING MOBILE TERMINALS HAVING SHORT LINK RADIOS

(57) Abstract: Methods and systems using short link radios (SLRs) with mobile terminals are disclosed. A mobile terminal having a SLR connects to other mobile terminals having SLRs over a SLR link to increase the troughput, the QoS, or both of the system. The mobile terminals establish a SLR link between a first mobile terminal and a second mobile terminal. Both mobile terminals receive data transmitted from a base station intended for the first mobile terminal. The second mobile terminal then retransmits the data received by the second mobile terminal to the first mobile terminal via the SLR link.

SYSTEMS USING MOBILE TERMINALS HAVING SHORT LINK RADIOS

BACKGROUND

The present invention relates to data communication systems. In particular, the invention relates to all mobile radio systems where the mobile terminals (MTs) use a Short Link Radio (SLR) to communicate with other mobile terminals, computers, printers, and the like. The invention proposes a method and system for improving the system throughput or quality of service (QoS) or both by connecting several mobile terminals together using the SLR.

Some applications in wireless data communications, for example video, internet browsing, and the like, require high bit rates over the air interface. This requires a mobile terminal that has large processing power and a large amount of memory to process high data rates.. However, for other applications, such as voice, text messaging, and the like, the requirements are often the opposite. The mobile terminal should be inexpensive and simple. The requirements can be contradictory and may depend on the field of application.

Land-mobile radio devices are well-known. Such devices typically include wireless communication circuitry that enables a wireless link to be established between the radio device and a geographically fixed base station. The base station serves as a relay that enables the radio device to established communication links not only with other land-mobile radio devices, but

also with land-based telephone and other communication equipment. A recent development in land-based radio devices is a proposal for the further inclusion of Short Link Radio circuitry, such as BLUETOOTH™. This additional circuitry enables wireless data connections to be established between one mobile terminal and other mobile terminals, computers, printers and the like without the need for an intermediary device, such as a base station. It is reasonable to expect a large number of cellular communication devices to include SLRs in the near future, because of the low implementation cost of SLRs in cellular devices and the range of new services emerging.

There is ever-increasing pressure to further improve data throughput and other Quality of Service (QoS) parameters in mobile devices. There is, therefore, a desire to provide additional wireless configurations to achieve these goals.

SUMMARY

It should be emphasized that the terms "comprises" and "comprising", when used in this specification, are taken to specify the presence of stated features, integers, steps or components; but the use of these terms does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

The invention overcomes the prior art limitations by using a mobile terminal having a SLR to connect to

other mobile terminals having SLRs over a SLR link to, for example, increase the throughput, the QoS, or both of the system. Preferably, the mobile terminals establish a SLR link between a master (or first) MT and a slave (or second) MT. The terms master MT and first MT are interchangeable, as are the terms slave MT and second MT. However, master MT and slave MT will generally be used in the following description.

In some embodiments, both mobile terminals receive data transmitted from a base station intended for the master MT. For example, the data could be redundant data. Alternatively, the data from the base station could be split and part transmitted directly to the master MT and part to the slave MT. In either case, the slave MT then retransmits the data received by the slave MT to the master MT via said SLR link. The data received by both the master MT and slave MT is combined and made available to the master MT.

In other embodiments of the invention, the slave MT can be used to forward the master MT's data to a base station.

In other embodiments, only the slave MT receives data transmitted from a base station intended for the master MT.

The above features and advantages of the invention will be more apparent and additional features and advantages of the invention will be appreciated from the following detailed description of the invention made with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described with reference to the following figures, in which:

Fig. 1 illustrates a system configuration of the current invention during a searching phase;

Fig. 2 illustrates establishing a SLR link between a master MT and a slave MT;

Fig. 3 illustrates signaling and data transfer over a SLR link between a master MT and a slave MT, data transmission between a base station and the slave MT, and data transmission between the base station and the master MT;

Fig. 4 illustrates a system configuration of the current invention with a cooperative link for increasing diversity gain;

Fig. 5 illustrates another example of system cooperation in which throughput is increased according to the invention;

Fig. 6 illustrates how the invention can be implemented on a mobile terminal; and

Fig. 7 shows flowchart for a method according to the invention.

DETAILED DESCRIPTION

Before addressing the specifics of the various embodiments of the invention a brief overview of the invention will be provided.

The invention provides a method and system for improving the user throughput and/or other Quality of

Service parameters in a cellular system, by directly connecting a plurality of mobile terminals together by means of Short Link Radio (SLR) circuitry. The operation of the mobile terminals with respect to a base station in the cellular system is coordinated to benefit one of the mobile terminals. For example, a mobile terminal (MT), here called master (or first), is connected to a base station (BS) by a long range cellular link. The master MT starts to search for other mobile terminals, here called slave(or second) MTs , that are willing to share their resources with the master MT. This search is performed by using the SLR of the master MT. The SLR may, for example, operate in accordance with BLUETOOTH™ technology standards. If a slave mobile terminal is found, information from the master MT is transmitted over the SLR to the slave MT that enables the link between the slave MT and the base station to be established. After the link is established the slave MT is able to receive data transmitted from the base station and which is intended for the master mobile terminal. The data received by the slave MT is then processed and relayed, via the SLR link, to the master MT, which combines and process the data. The advantages of connecting the master MT and slave MT together via the SLR-link are twofold. First, a diversity gain can be obtained as a result of the physical separation between the master MT and slave MT. Second, the processing of received data can be distributed on more than one receiver. The result in

both cases above is that the user experiences a higher throughput and/or better QoS.

In the following description of the invention, reference numbers will be maintained between drawings where the items referenced are the same. Therefore, reference numbers for a particular figure may not be discussed where the information provided would be redundant.

Referring to Fig. 1, a master mobile terminal (MT) 10 is connected to a base station (BS) 20 via a wireless connection 101 (e.g., a radio link in a cellular telephone system) and data is transferred between the base station 20 and the master MT 10, by transceiver 12. In order to try to increase the throughput of the master MT, the master MT starts to scan the surroundings by using SLR 11 to find other mobile terminals 30 and 40 willing and able to cooperate. If the master MT 10 finds mobile terminals 30 and 40, that are willing and able to cooperate, the master MT starts transmitting signaling information through the SLR 11. Because of the role they play in this scenario, the mobile terminals 30 and 40 are herein denoted as "slave MTs." It will be recognized, however, that there need not be any inherent physical distinction between the slave MTs 30 and 40 and the master MT 10.

The signaling information is necessary to establish a link for the slave MTs 30 and 40 to transmit and receive data intended for the master MT 10 to and from the base station 20. The master MT 10 can use SLR 11 to

directly communicate with slave MTs 30 and 40, via their SLRs 31 and 41, respectively. Additionally, slave MTs 30 and 40 have transceivers 32 and 42, respectively for communicating with base station 20.

Fig. 2 shows the establishment of a SLR link between the master MT 10 and the slave MT 30. Initialization includes providing the slave MT 30 with signaling information, such as the carrier frequency to transmit and receive on, which time slot/slots to use, and the like, that it will need to communicate with the base station 20 on behalf of the master MT 10. The signaling information comprises: the carrier frequency to transmit and receive on; which time slot/slots to use; and necessary master MT identification information. In an exemplary embodiment, the master MT 10 uses the SLR link 50 to supply the signaling information to the slave MT 30.

Referring to Fig. 3, the slave MT 30 starts to receive data from and transmit data to the base station 20, via transceiver 32, when it has received necessary data from the master MT 10 over the SLR link 50 using SLRs 31 and 11, respectively. The slave MT 30 may pre-process the received data to comply with the chosen diversity method and then transmit the pre-processed data to the master MT 10 over the SLR link 50, or the slave MT 30 may simply relay the data to the master MT 10 without further processing.

Fig. 3 illustrates cooperation between master MT 10 and slave MT 30. Data transmitted from the base station

20, intended for the master MT 10, is received by the slave MT 30 using transceiver 32. The slave MT 30 then simply relays the data to the master MT 10, over the SLR link 50, using SLRs 31 and 11, respectively. The master MT 10 can, but is not required to, simultaneously receive data from the base station 20 via transceiver 12. In one configuration the data from the base station 20 transmitted over the cellular connection is divided between the master MT 10 and slave MT 30. However, all data transmitted from the base station directed to the master MT 10 will be received by the master MT 10 by concatenating the data received directly from the base station 20 with data received indirectly via the slave MT 30. This configuration allows for an increased throughput to the master MT. Additional slave MTs could be used to further increase the throughput to master MT 10. The configuration illustrated in Fig. 3 is also useful for diversity combining as described below in regard to Fig. 4. Additionally, in some configurations the control signaling between base station 20 and slave MT 30 in Fig. 3 is actually control signaling intended for the master MT 10 since the base station does not know about the slave, i.e., all necessary control signaling goes through the master MT 10. Alternatively, where the base station 20 knows about the slave MT 30, i.e., the Master MT tells the base station 20 about the slave MT 30, the base station 20 optimizes the throughput or diversity gain based on its knowledge of the slave MT 30.

In Fig. 4, the cooperation between mobile terminals is based on diversity. The master MT 10 and the slave MT 30 receive and/or transmit identical information from/to the base station 20. The information is thus propagated through different signal paths and/or radio channels due to the physical separation between the master MT 10 and the slave MT 30. The reception is done in a way which is known in the art, for example GSM receivers. In the downlink direction, the slave MT 30 receives the radio-signal and down converts it to a baseband signal in the front-end receiver (Fe Rx) 35. The baseband signal is then fed to the SLR 31, via a control unit (CU) 34 that optionally performs certain baseband pre-processing, and retransmitted via SLR link 50 to the master MT 10. The necessary signal processing, to receive, convert, and retransmit the data by the slave MT 30, is performed by the slave MT 30 using digital signal processor (DSP) 36 and other components integrated into the slave mobile terminal 30, as is known in the art. The master MT 10 receives the data using SLR 11, feeds it via the control unit 14 to a DSP 16 which combines the data received from the slave MT 30 with the data received by the master MT 10 itself from the base station 20 via the master's Fe Rx 15. The data can then be used by an application 18, converted to voice, and the like. The base station 20 is not affected by this diversity arrangement. Therefore, it is not necessary for the base station 20 to know that more than one mobile terminal is involved in receiving

data intended for the master MT 10. The combination of signals in the master MT 10 results in a diversity gain that can be substantial even for a limited number of slave MTs. Any kind of known diversity combining technique can be used, such as maximum-ratio combining.

In Fig. 5, the SLR link 50 is used to distribute the data processing of the received information among several mobile terminals. In a TDMA system, for example, the master MT 10 can be made responsible for reception and decoding of the data received in some of the time slots (denoted TS A), while the slave MT 30 can be made responsible for reception and decoding of data received in other time slots (denoted TS B). One skilled in the art will appreciate that the invention is not limited to TDMA systems and can be adapted to other systems such as CDMA, FDMA and the like. For instance, in a CDMA system different access codes are used instead of different time slots. The slave MT 30 does all low-layer processing, such as down-conversion to baseband in the front-end receiver 35 and detection, decoding and the like. The decoded data is delivered over the SLR link 50 to the master MT 10, which then does the higher layer processing. The nature of the higher layer processing depends on which application 18 is run on the master MT 10. This procedure results in higher throughput for the master MT 10. There is no need for the base station 20 to be aware that the signals are being received by different mobile terminals because all control signaling goes through the master MT 10. The

master MT 10 negotiates with the base station 20 how much system resources can be allocated, and the slave MT 30 does not take any part in that negotiation. It is then up to the master MT 10 and the slave MT 30 to share the traffic load between them to maximize the throughput. The coordination between the master MT 10 and slave MT 30 is conducted via the SLR link 50.

In another aspect of the invention, security can be improved by allowing a master MT to use a slave MT's radio and data-interface only if the slave MT is open for access by the mobile terminals of other users. In Fig. 6, an example of such a service is shown. In the slave MT's menu system is a menu, as displayed on display 310, wherein the user can choose whether the terminal is "open" to other users or not. If the user wants to use this option he or she chooses "YES" by activating the YES key 301, otherwise "NO" by activating the NO key 302 on keypad 305. Under the direction of control logic (not shown) within the mobile terminal 300, choosing "YES" causes the mobile terminal 300 to allow other mobile terminals to use the mobile terminal 300 as a slave MT. In some embodiments, choosing "YES" may also put the user's mobile terminal 300 into a state that permits it to take advantage of other open mobile terminals (not shown). Alternatively, the option of whether to have an "open" or "locked" mobile terminal can be decided by the system operator or hardwired by the mobile terminal manufacturer.

Referring to Fig. 7, a flowchart for an exemplary method of the invention is shown. The method in the master (or first) MT starts by searching for potential slave (or second) MTs, in step 700. The master MT establishes a first link to a base station and a second link to a slave MT (e.g., as found in step 700), in steps 710 and 720, respectively. In step 705, a decision is made in the potential slave MT as to whether it is available to be a slave MT. This decision can be made by a user of the potential slave MT, for example, via a menu selection or pre-configured in potential slave MT. If the potential slave MT is open for access, then the slave MT cooperates in establishing the second link with the master MT in step 715. Preferably, the second link between the master MT and the slave MT is a SLR link. Optionally, the slave MT can additionally establish its own link (referred to herein as a "third link") to the base station, in step 725. The master MT in this case uses the second link to inform the slave MT of all necessary parameters for effectively utilizing the first link that was established between the master MT and the base station. However, the slave MT may also receive the data transmitted from the base station, without establishing another link.

One skilled in the art will recognize there may be many additional combinations when multiple slave MT's are present, such as each slave MT having independent links, some slave MTs having independent links and others just receiving data without establishing a link

to the base station, and the like. The system configuration will be controlled by many considerations such as the number of slave MTs available, whether the master MT is trying to use diversity to improve QoS or achieve maximum through put, system resources available, and the like, as will be appreciated by those skilled in the art. In step 735, the slave MT transmits data, derived from the data that the slave MT has received from the base station, to the master MT. In step 730, the master MT receives data via the second link from the slave MT. The data received from the slave MT is combined with the data that the master MT receives directly from the base station, in step 740. For example, the data could be redundant data that is combined in the master MT for the purpose of achieving diversity gain. Alternatively, the data from the base station intended for the master MT could be split and part received by the master MT and part received by slave MT. The data received by the slave MT is forwarded to the master MT and is combined with the data directly received by the master MT to form the complete message transmitted from the base station. Finally, in step 750, the data is supplied to an application in the master MT.

In another aspect of the invention, a mechanism for authentication between master and slave mobile terminals should be provided. Otherwise, a slave mobile terminal may route data to a fake master, and security is breached.

A crypto-mechanism above the protocol-levels involved in the slave MT's data-processing mentioned above facilitates a secure link between the slave MT and the terminating application in the master MT. The data linked from the base station to the master MT via the slave MT can then be regarded as securely relayed although some data-processing is done in the slave MT.

The foregoing has described the principles, preferred embodiments and modes of operation of the invention. However, the invention should not be construed as being limited to the particular embodiments discussed above. For example, several different receive and transmit scenarios are possible such as: the master MT only receives and the one or more slave MTs only transmit; the one or more slave MTs only receive and the master MT only transmits; and the one or more slave MTs receive and transmit while the master MT processes data.

In another configuration, a computer equipped with a SLR connects to the master MT by using the SLR link. The computer or the master MT then searches for slave MTs that permit SLR-access. The slave MTs do all reception and transmission while the computer does the high layer processing. Data received from the slave MT or the master MT or both could be provided to applications residing in the computer.

In another example, a handover between two different mobile terminals during a call is accomplished using SLRs. For example, suppose the master MT is the mobile terminal that handles the call before handover.

The master MT may then initiate a handover to a slave MT by transmitting the necessary information, such as carrier frequency, time slot, spreading code, identification information, and the like to the slave MT over the SLR link. The master MT then controls the actual handover via the SLR link. When the handover is completed, the master MT disables the SLR connection to the slave MT. The slave MT then handles all transmission to/from the base station using the master MT's identity. This reduces the system (i.e., network) signaling during a handover by using the SLR link.

Still another feature of the SLR link between the master MT and slave MTs allows data (i.e., calls) to be distributed to users of the slave MTs, for example to establish multi-part calls (i.e., conference calls). For example, a call received by the master MT may be distributed to the slave MTs via the SLR link. The users of the slave MTs could then relay their response data (i.e., the users' voices) to the master MT via the SLR link. The master MT then combines the response data from the slave MTs along with the master's response data and transmits the combined response data to the base station. Many variations of this process will be recognized by those skilled in the art. For example, the master MT may not directly receive/transmit any data from/to the base station but could instead delegate that to one or more slave MTs to obtain diversity or increased throughput as described above.

Therefore, the above-described embodiments should be regarded as illustrative rather than restrictive, and it should be appreciated that variations may be made in those embodiments by workers skilled in the art without departing from the scope of the invention as defined by the following claims.

CLAIMS

What is claimed is:

1. A method of operating a first mobile terminal (MT), comprising:

establishing a first link to a base station;

establishing a second link to a second mobile terminal; and

receiving data from the second mobile terminal via the second link, wherein the data is derived from data that was transmitted from the base station to the second mobile terminal.

2. The method of claim 1, wherein the first link is a cellular communication radio link, and the second link is a short link radio (SLR) link.

3. The method of claim 2, wherein the SLR link operates in accordance with BLUETOOTH™ standards.

4. The method of claim 2, wherein establishing the SLR link comprises:

searching for a potential second MT by the first MT using a SLR; and

querying the potential second MT for availability to act as the second MT.

5. The method of claim 1, further comprising:

establishing at least one additional link with at least one additional MT.

6. The method of claim 5, wherein the at least one additional link is a SLR link.

7. The method of claim 5, wherein at least one additional SLR link operates in accordance with BLUETOOTH™ standards.

8. The method of claim 1, further comprising:
supplying the data to an application in the first MT.

9. The method of claim 1, wherein the data is processed in the second MT prior to being received by the first MT.

10. The method of claim 1, wherein the data received from the second MT is the same as data directly received from the base station.

11. The method of claim 10, further comprising:
combining the data received from the second MT with data directly received from the base station using a diversity combining technique.

12. The method of claim 11, wherein the diversity combining technique is maximum-ratio combining.

13. The method of claim 1 wherein the data received from the second MT is different from data directly received from the base station.

14. The method of claim 13, further comprising:
concatenating data from the second MT and the data received directly from the base station to recreate data transmitted by the base station intended for the first MT.

15. The method of claim 1, further comprising:
negotiating with the base station to establish the first link and a third link, wherein the third link is between the base station and the second MT.

16. The method of claim 15, further comprising:
receiving data from the base station in a TDMA system, wherein the first MT receives data in a first time slot and the second MT receives data in a second time slot, via the third link.

17. The method of claim 15, further comprising:
receiving data from the base station in a CDMA system, wherein the first MT receives data using a first access code and the second MT receives data using a second access code, via the third link.

18. The method of claim 1, further comprising:

authenticating the second MT to prevent data intended for the first MT from being routed to another device.

19. The method of claim 1, further comprising:
encrypting the data via a crypto-mechanism that permits secure data transmission with the second MT.

20. The method of claim 1, further comprising:
initiating a handover to the second MT by transmitting handover control information to the second MT over the second link;
controlling the handover via the second link; and
disabling the second link to the second MT when the handover is completed.

21. The method of claim 1, further comprising:
distributing the data to a user of the slave MT via the second link.

22. The method of claim 21, wherein the data is distributed to the user to establish multi-part calls.

23. A method for operating a system comprising a first mobile terminal, a second mobile terminal and a base station, the method comprising:
establishing a first link between the first mobile terminal and the base station;

establishing a second link between the first mobile terminal and the second mobile terminal; and

receiving data from the second mobile terminal via the second link, wherein the data is derived from data that was transmitted from the base station to the second mobile terminal.

24. The method of claim 23, wherein the first link is a cellular communication radio link, and the second link is a SLR link.

25. The method of claim 24, wherein the SLR link operates in accordance with BLUETOOTH™ standards.

26. The method of claim 24, wherein establishing the SLR link comprises:

searching for a potential second MT, by the first MT, using a SLR;

querying the potential second MT, by the first MT, for availability to act as the second MT; and

acknowledging availability by the second MT.

27. The method of claim 23, further comprising:

establishing at least one additional link between the first MT and at least one additional MT.

28. The method of claim 23, further comprising:

establishing a third link between the second mobile terminal and the base station.

29. The method of claim 28, further comprising:

receiving data from the base station in a TDMA system, wherein the first MT receives data in a first time slot and the second MT receives data in a second time slot, via the third link.

30. The method of claim 28, further comprising:

receiving data from the base station in a CDMA system, wherein the first MT receives data using a first access code and the second MT receives data using a second access code, via the third link.

31. A system comprising:

a first mobile terminal (MT);

a second mobile terminal (MT);

a base station;

circuitry for establishing a first link between the first MT and the base station; and

circuitry for establishing a second link between the first MT and the second MT, wherein the first MT receives data via the second link and wherein the data is derived from data that was transmitted from the base station to the second MT.

32. The system of claim 31, wherein the first link is a cellular communication radio link, and the second link is a short link radio (SLR) link.

33. The system of claim 32, wherein the SLR link operates in accordance with BLUETOOTH™ standards.

34. The system of claim 31, further comprising:
circuitry for establishing at least one additional link between the first MT and at least one additional MT.

35. The system of claim 31, further comprising:
circuitry for establishing a third link between the second MT and the base station.

36. The system of claim 35, wherein the system is a TDMA system and wherein the first MT receives data in a first time slot and the second MT receives data in a second time slot, via the third link.

37. The system of claim 35, wherein the system is a CDMA system and wherein the first MT receives data using a first access code and the second MT receives data using a second access code, via the third link.

38. The system of claim 35, wherein the first MT comprises:
circuitry for negotiating with the base station to establish the first and third links.

39. The system of claim 31, further comprising:

a selection device in the second MT that opens the second MT for access by the first MT.

40. The system of claim 39, wherein the selection device comprises:

an option in a menu system.

41. The system of claim 39, wherein the selection device comprises:

a pre-configured option selected by a mobile terminal manufacturer or by a system operator.

42. The system of claim 31, further comprising:

an authenticating system that prevents data intended for the first MT from being routed to another device.

43. The system of claim 31, further comprising:

a crypto-mechanism that permits secure data transmission between the second MT and the first MT.

44. A method of operating a second mobile terminal (MT), comprising:

cooperating with a first mobile terminal (MT) to establish a first link to the first mobile terminal; and

transmitting data to the first mobile terminal via the first link, wherein the data is derived from data that was transmitted from the base station to the second mobile terminal.

45. The method of claim 44, wherein the first link is a short link radio (SLR) link.

46. The method of claim 45, wherein the SLR link operates in accordance with BLUETOOTH™ standards.

47. The method of claim 45, wherein cooperating to establish the SLR link comprises:
acknowledging availability to act as the second MT.

48. The method of claim 44, further comprising:
processing the data prior to transmitting the data to the first MT.

49. The method of claim 44, further comprising:
establishing a second link to a base station.

50. The method of claim 49, further comprising:
receiving data from the base station in a TDMA system, wherein the first MT receives data in a first time slot and the second MT receives data in a second time slot, via the second link.

51. The method of claim 49, further comprising:
receiving data from the base station in a CDMA system, wherein the first MT receives data using a first access code and the second MT receives data using a second access code, via the second link.

52. The method of claim 44, further comprising:
opening for access by the first MT via a selection device in the second MT.

53. The method of claim 52, wherein the selection device comprises:
an option in a menu system.

54. The method of claim 52, wherein the selection device comprises:
a pre-configured option selected by a mobile terminal manufacturer or by a system operator.

55. The method of claim 44, further comprising:
authenticating the first MT to prevent data intended for the first MT from being routed to another device.

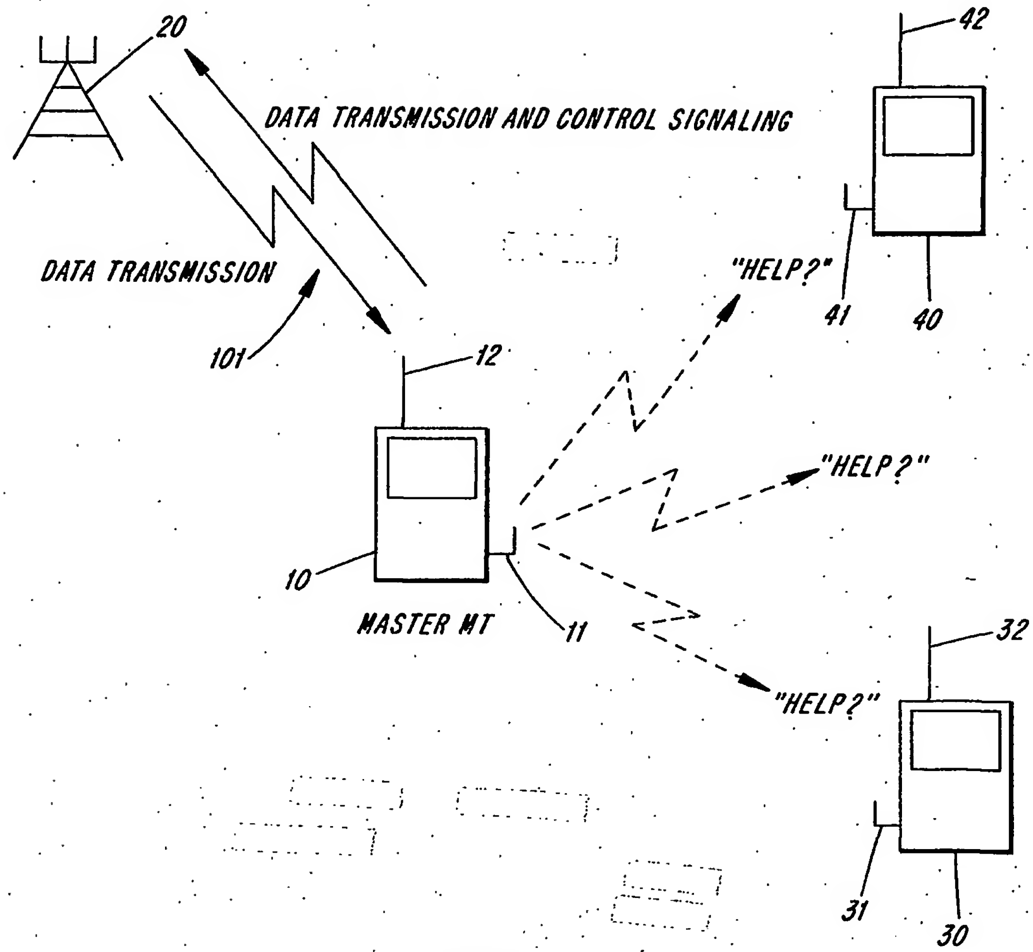
56. The method of claim 44, further comprising:
encrypting the data via a crypto-mechanism that permits secure data transmission with an application in the first MT.

57. A method of operating a first mobile terminal (MT), comprising:
establishing a second link to a second mobile terminal; and
relaying data with the second MT via the second link, wherein the data is also relayed between the base

station and the second MT via a first link between the second MT and the base station.

58. The method of claim 57, wherein the first link is a cellular communication radio link, and the second link is a short link radio (SLR) link.

59. The method of claim 58, wherein the SLR link operates in accordance with BLUETOOTH™ standards.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DATA TRANSMISSION AND CONTROL SIGNALING
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MASTER MT
11
"HELP?"
"HELP?"
"HELP?"
42
41
40
32
31
30

FIG. 1

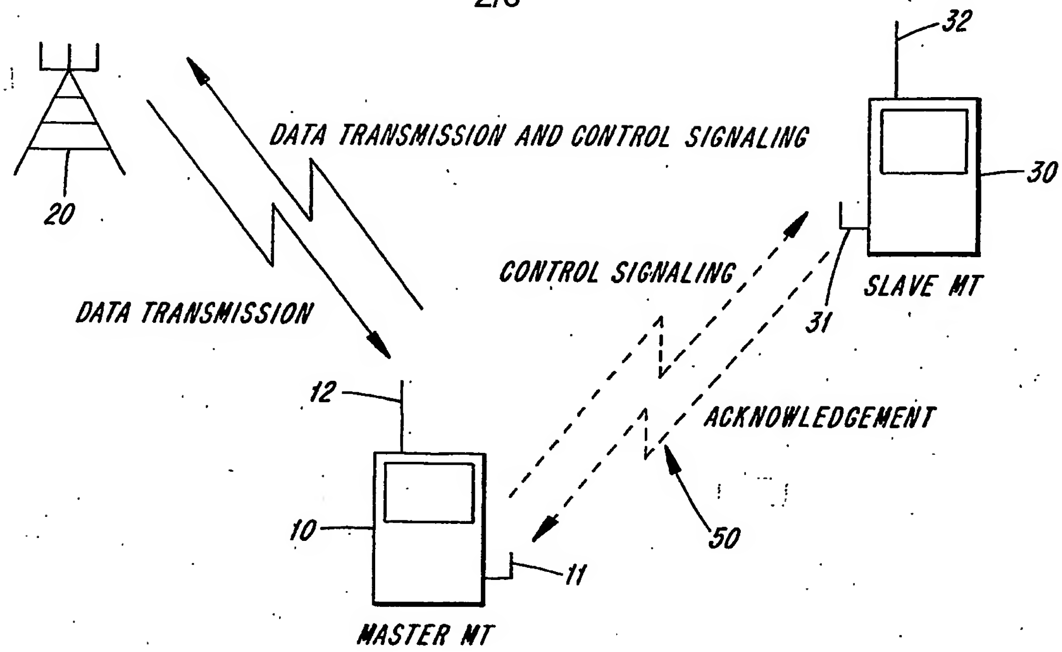
DATA TRANSMISSION AND CONTROL SIGNALING
DATA TRANSMISSION
CONTROL SIGNALING
ACKNOWLEDGEMENT
SLAVE MT
MASTER MT
32
30
31
20
12
10
11
50

FIG. 2

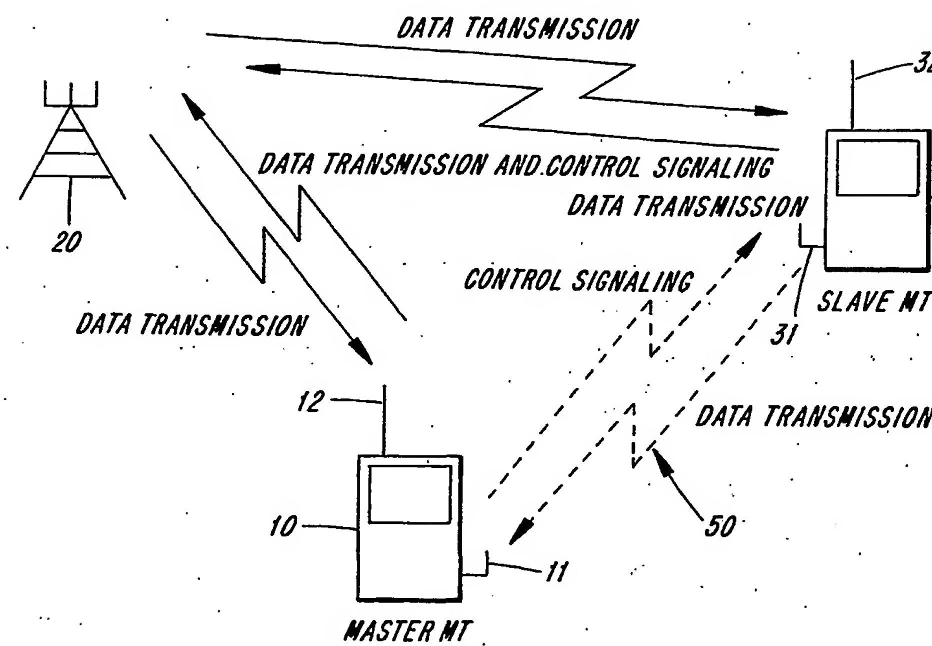
DATA TRANSMISSION
DATA TRANSMISSION AND CONTROL SIGNALING
DATA TRANSMISSION
CONTROL SIGNALING
DATA TRANSMISSION
DATA TRANSMISSION
SLAVE MT
MASTER MT
32
30
31
20
12
10
11
50

FIG. 3

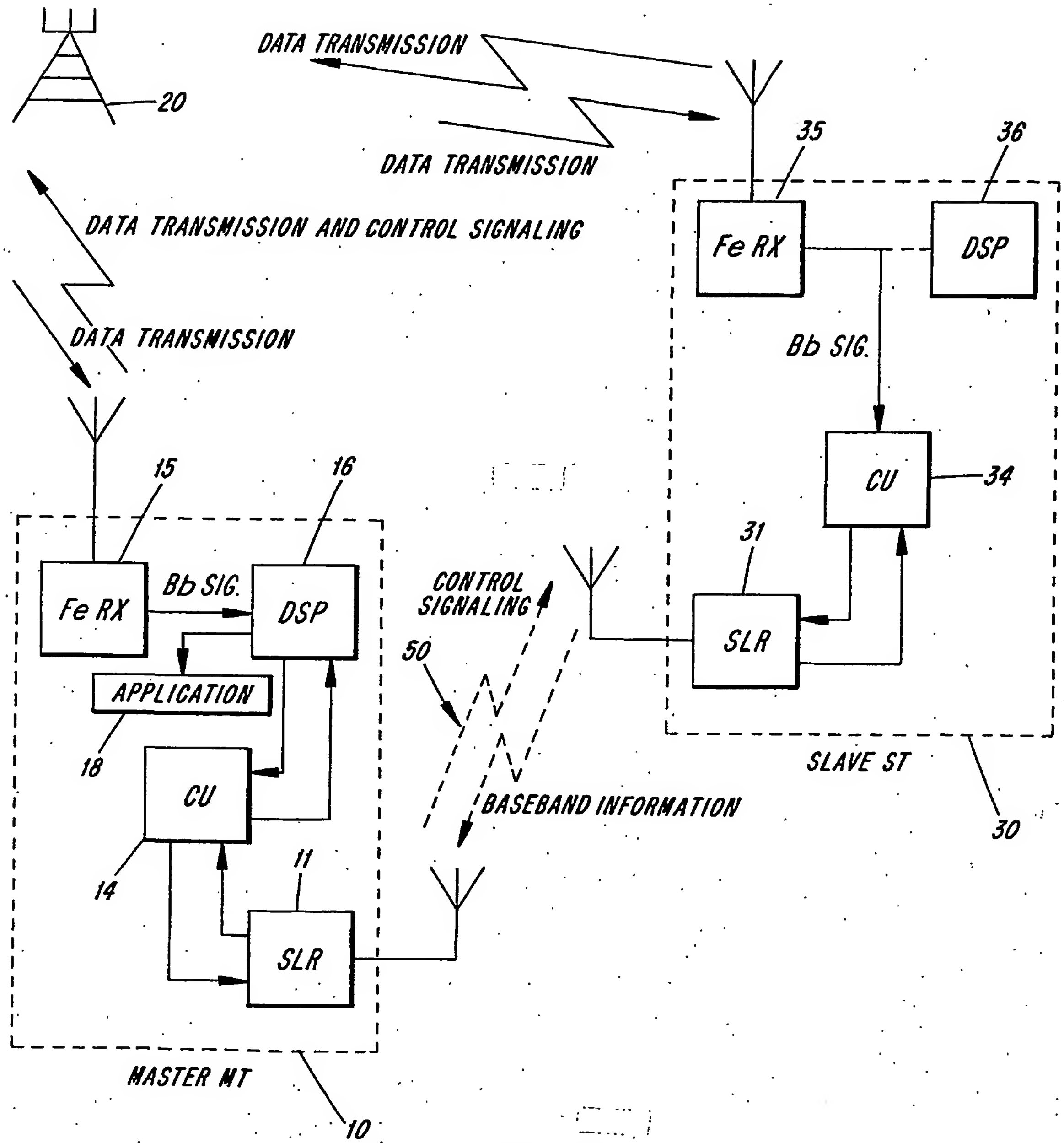
DATA TRANSMISSION
20
DATA TRANSMISSION
35
36
DATA TRANSMISSION AND CONTROL SIGNALING
Fe RX
DSP
DATA TRANSMISSION
Bb SIG.
15
16
CU
34
31
Fe RX
Bb SIG.
DSP
CONTROL SIGNALING
50
SLR
APPLICATION
18
CU
SLAVE ST
BASEBAND INFORMATION
30
14
11
SLR
MASTER MT
10

FIG. 4

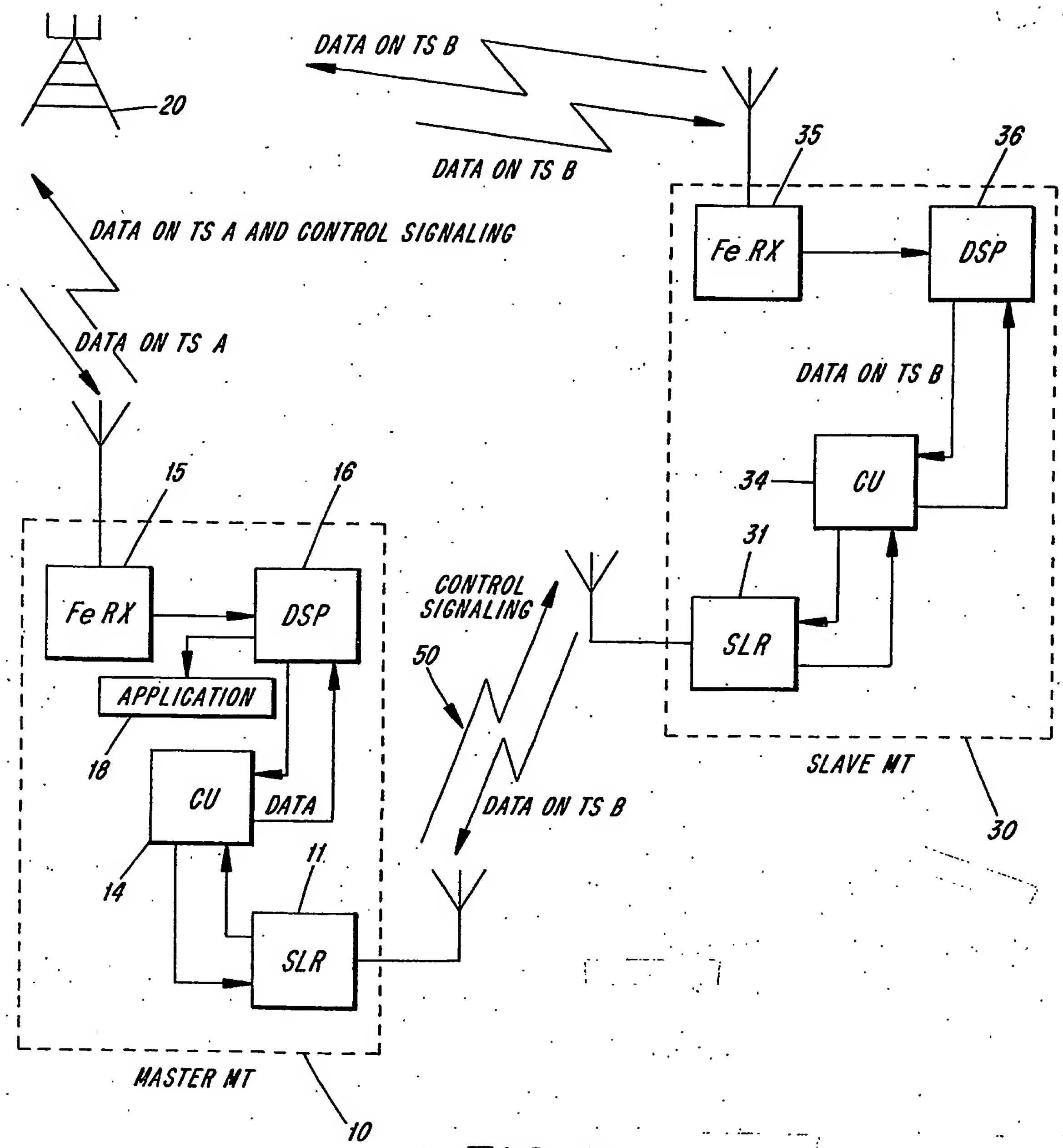
DATA ON TS B
20
DATA ON TS B
35
36
DATA ON TS A AND CONTROL SIGNALING
Fe RX
DSP
DATA ON TS A
DATA ON TS B
15
16
34
CU
31
Fe RX
DSP
CONTROL SIGNALING
APPLICATION
50
SLR
18
CU
DATA
DATA ON TS B
SLAVE MT
30
14
11
SLR
MASTER MT
10

FIG. 5

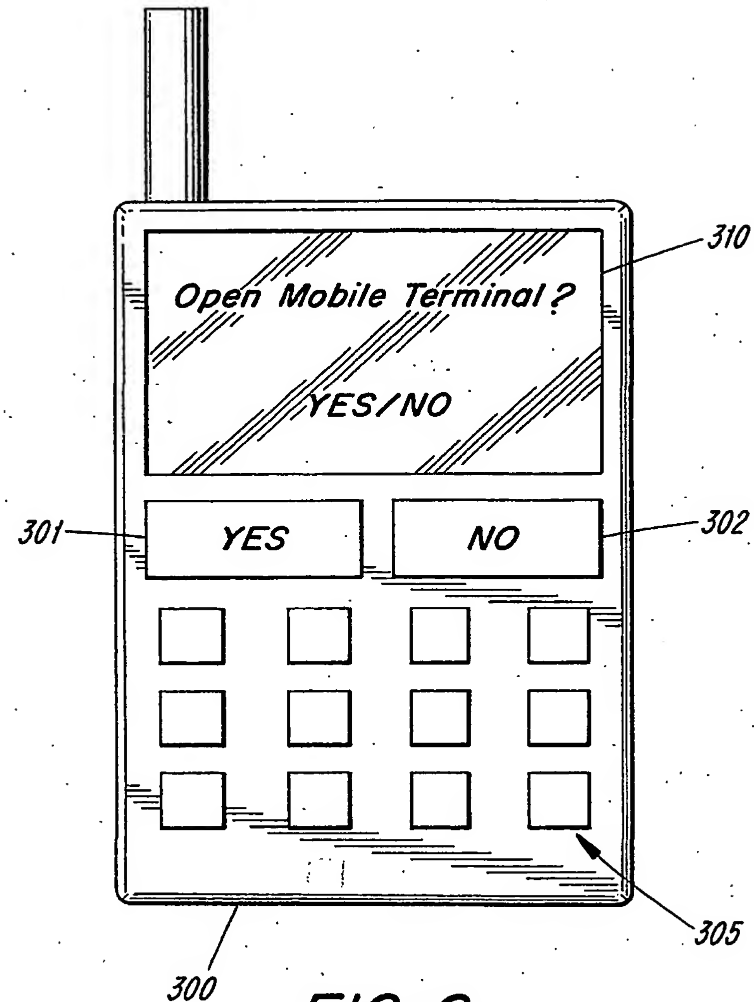

FIG. 6

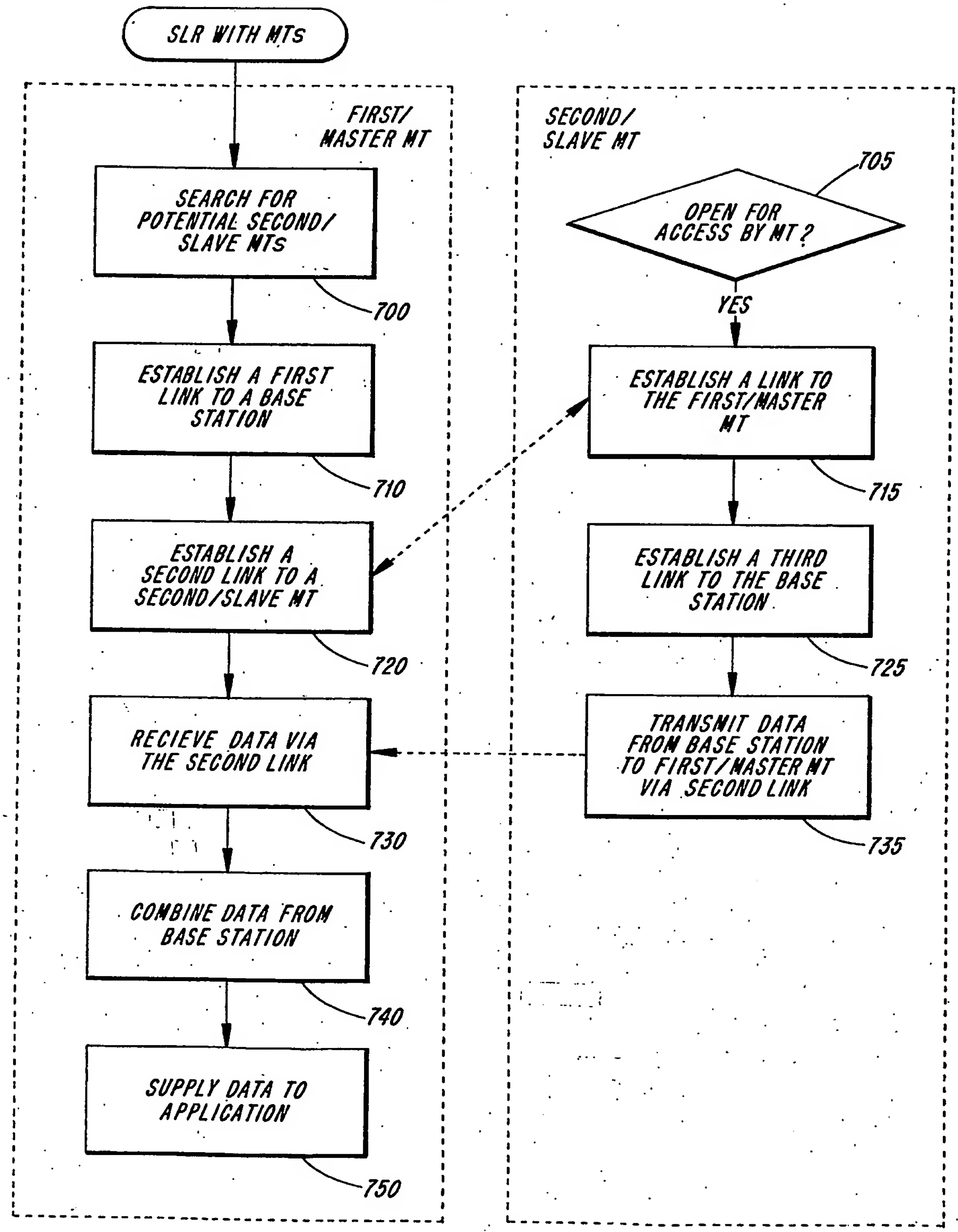
SLR WITH MTs
FIRST/ MASTER MT
SEARCH FOR POTENTIAL SECOND/ SLAVE MTs
700
ESTABLISH A FIRST LINK TO A BASE STATION
710
ESTABLISH A SECOND LINK TO A SECOND/SLAVE MT
720
RECIEVE DATA VIA THE SECOND LINK
730
COMBINE DATA FROM BASE STATION
740
SUPPLY DATA TO APPLICATION
750
SECOND/ SLAVE MT
705
OPEN FOR ACCESS BY MT ?
YES
ESTABLISH A LINK TO THE FIRST/MASTER MT
715
ESTABLISH A THIRD LINK TO THE BASE STATION
725
TRANSMIT DATA FROM BASE STATION TO FIRST/MASTER MT VIA SECOND LINK
735

FIG. 7